PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-309071

(43)Date of publication of application : 17.11.1998

(51)Int.Cl. H02K 41/02
H01L 21/027
H01L 21/68

(21)Application number : 09-195600

(22)Date of filing : 22.07.1997

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(30)Priority

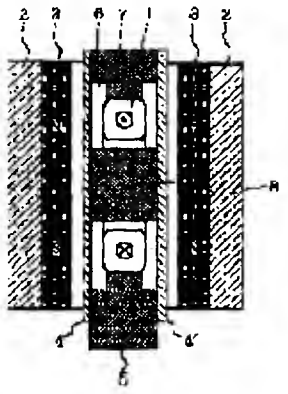
Priority number : 09 51726 Priority date : 06.03.1997 Priority country : JP

(54) LINEAR MOTOR AND STAGE DEVICE OR ALIGNER USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To increase the output of a jacket by suppressing the deformation and breakage of the jacket even when the pressure of a coolant is increased or the size of the jacket is reduced, by providing a reinforcing member which reinforces the jacket against the pressure of the coolant in the jacket.

SOLUTION: In a linear motor, a reinforcing member 8 is stuck or bolted to both sheets 4 and 4' as a pressure-resistant tool which prevents the expansion of the interval between the sheets 4 and 4'. In this linear motor, the heat generated from a coil 1 when the coil 1 is energized is recovered so as to suppress the temperature rise of the coil 1 itself and a device, etc., mounted with the linear motor, by making a temperature-controlled coolant flow to the internal space 6 of a jacket. When the coolant is made to flow, the reinforcing member 8 suppresses the deformation of the sheets 4 and 4' which are expanded outward by the pressure of the coolant. Therefore, the cooling efficiency of the jacket can be improved by increasing the flow rate of the coolant and, at the same time, the



size of the jacket can be reduced, because the deformation or breakage of the jacket can be suppressed even when the pressure of the coolant is raised or the thicknesses of the sheets 4 and 4' of the jacket are reduced.

LEGAL STATUS

[Date of request for examination]	22.03.2000
[Date of sending the examiner's decision of rejection]	31.07.2001
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3278380
[Date of registration]	15.02.2002
[Number of appeal against examiner's decision of rejection]	2001-15426
[Date of requesting appeal against examiner's decision of rejection]	30.08.2001
[Date of extinction of right]	

* NOTICES *

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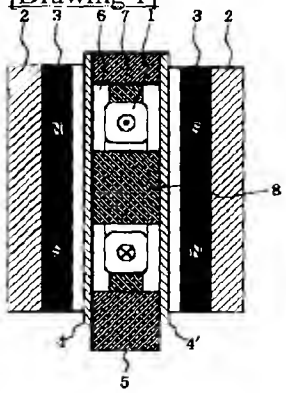
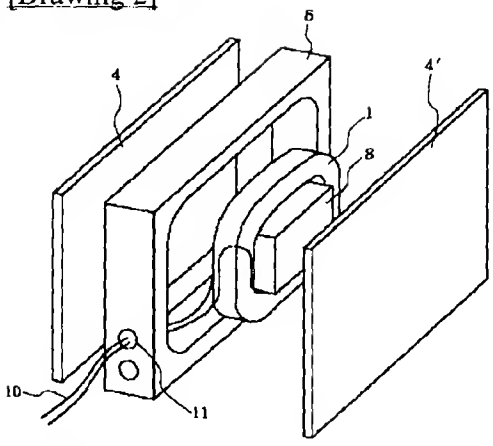
DRAWINGS

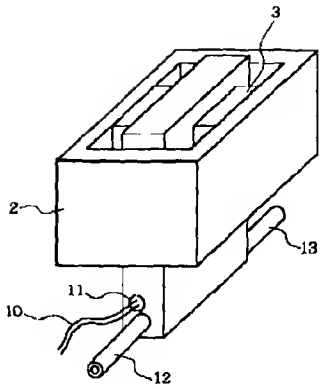
[Drawing 1]



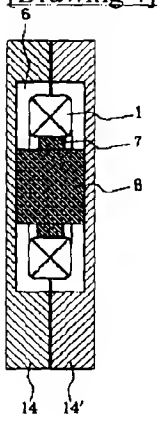
[Drawing 2]



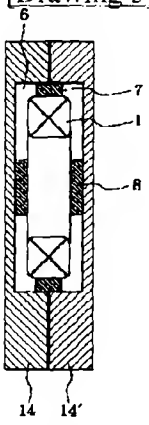
[Drawing 3]



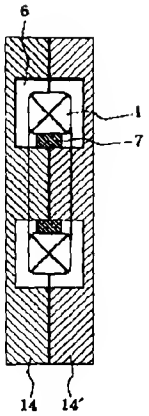
[Drawing 4]



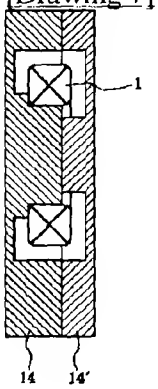
[Drawing 5]



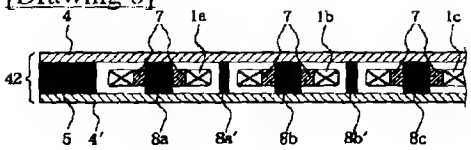
[Drawing 6]



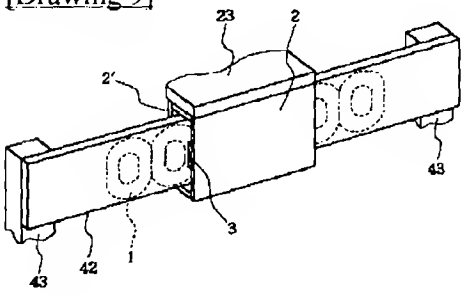
[Drawing 7]



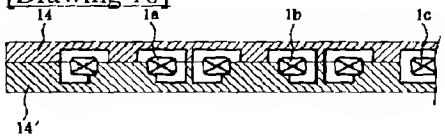
[Drawing 8]



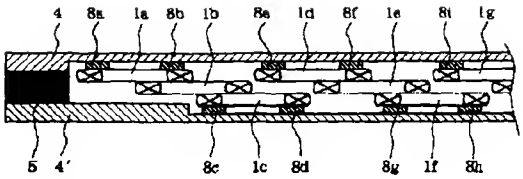
[Drawing 9]



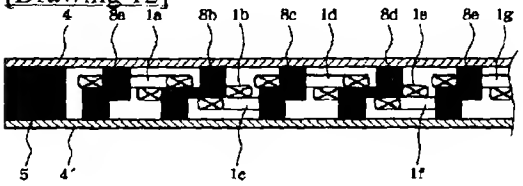
[Drawing 10]



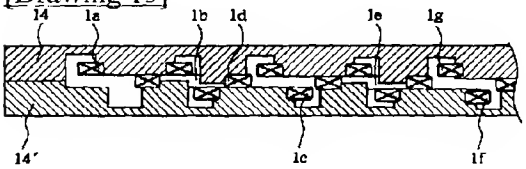
[Drawing 11]



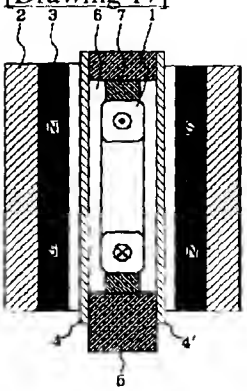
[Drawing 12]



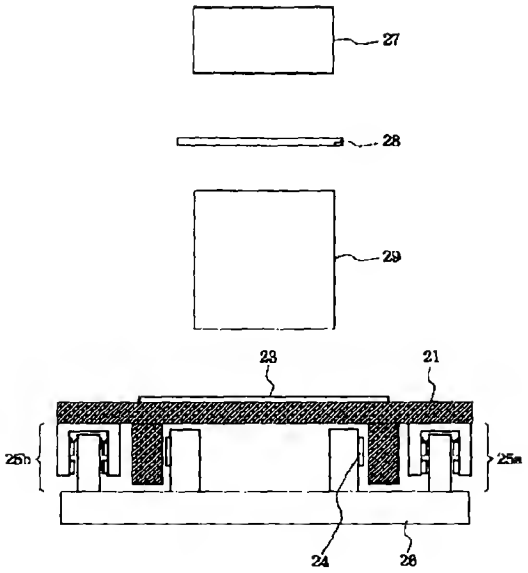
[Drawing 13]



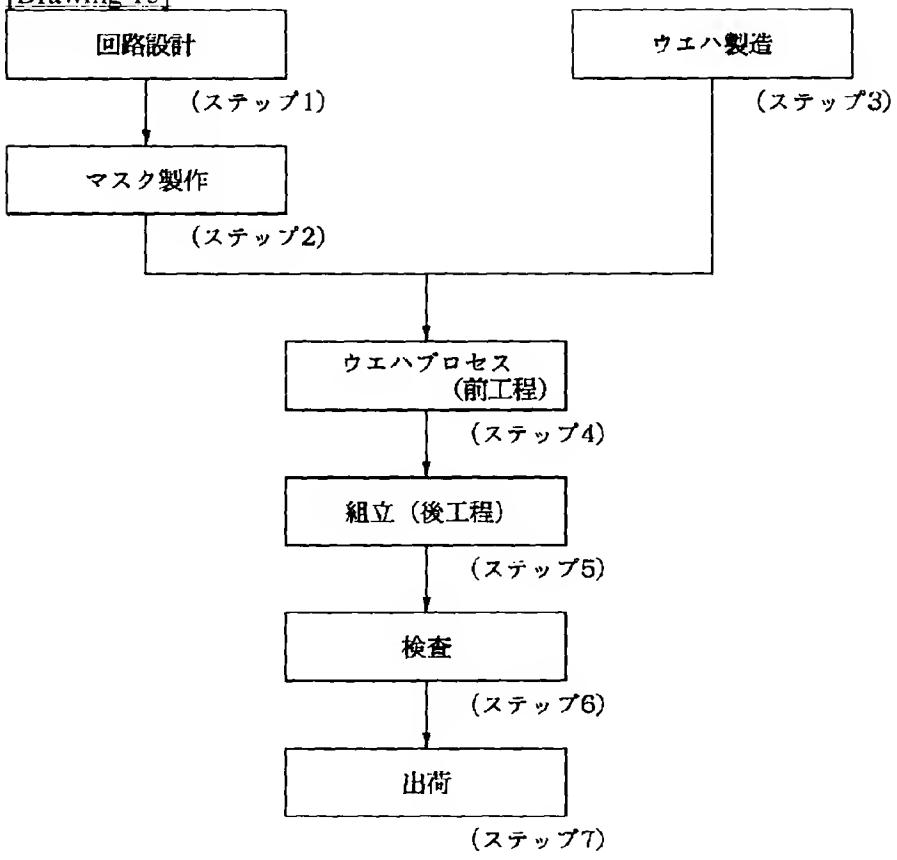
[Drawing 17]



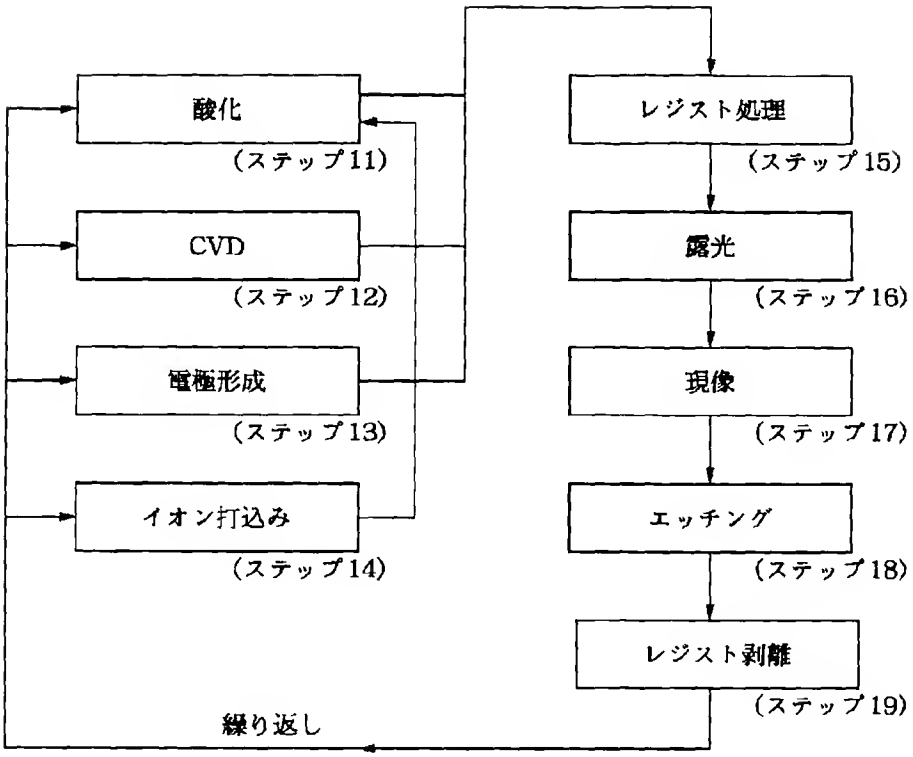
[Drawing 14]



[Drawing 15]



[Drawing 16]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the linear motor used suitable for the equipment for performing precise positioning, such as for example, a semiconductor aligner and a high precision finishing machine, etc.
[0002]
[Description of the Prior Art] In the pointing device of the nano meter order used by the semiconductor aligner, the high precision finishing machine, etc., generation of heat from the linear motor which is a driving source has a bad influence on positioning. According to factors, such as a measurement error of the laser interferometer of the position measurement by heat deformation of the structure by generation of heat, or elevation of air temperature, the positioning accuracy of the equipment with which the linear motor was carried gets worse. For example, even if it is a 1-degree C temperature change, 100mm low-fever expansion material (coefficient of thermal expansion 1x10-6) transforms only 100nm, and even if change of the air temperature in the optical path of an optical interference formula length measurement meter is 1 degree C or less, a 100nm error may arise in measured value. Therefore, cooling of a linear motor, especially recovery of the heat generated from a linear motor are needed as a preventive measure of these temperature changes.
[0003] On the other hand, with highly-efficient-izing of equipment, the high increase in power of a linear motor is demanded, and if the current which flows in a coil for the reason is increased, calorific value will also increase greatly. Therefore, reinforcement of the further refrigeration capacity is needed. Moreover, in order to prevent the increase in coil resistance and the breakage of a coil line by elevation of coil temperature, it is important to heighten the refrigeration capacity of a coil.
[0004] The example of the linear motor equipped with the cooling means of a coil is indicated by JP,7-302124,A, JP,7-302747,A, and JP,8-167554,A.
[0005] Drawing 17 is drawing showing the composition of the conventional linear motor equipped with the cooling means. In this drawing, it is constituted by the permanent magnet 3 fixed to the coil 1 and the yoke 2 of the both sides, and the coil 1 is covered in the jacket 8 which consisted of a sheet 4 of closing in, 4', and a frame 5. The coil 1 is being fixed to the frame 5 by the fastener 7. The generating heat from a coil is collected by pouring a refrigerant to the building envelope 6 of a jacket 8 here.
[0006]
[Problem(s) to be Solved by the Invention] However, since the closing-in portion of a jacket deforms in the direction of outside by the pressure buildup of a refrigerant, a permanent magnet is contacted or there is a possibility that a jacket may be damaged when the flow rate of a refrigerant is made to increase, in order to improve refrigeration capacity, in order to prevent this, the intensity of the closing-in section of a jacket needs to be secured of the above-mentioned conventional example. On the other hand, for the high increase in power of a linear motor, it is necessary to make distance between permanent magnets small and to raise flux density, and there is also contrary demand of wanting to make a closing-in portion as thin as possible for this reason, and to miniaturize a jacket.

[0007] It was madc that this invention should solvc the above-mentioned technical problem, whcther it incrcases the prcssure of a refrigerant or miniaturizes a jacket, dcformation and breakage of a jacket are suppressed, and it aims at offering the linear motor which achieved a high increasc in powcr more than before. It aims at offcring outstanding stage equipment and the outstanding aligner which furthermorc uscd this lincar motor, the device manufacture method, etc.
[0008]
[Means for Solving the Problem] Onc of thc desirable gestalten of this invcntion which attains the above-mentioned purpose is a lincar motor characterized by prcparing the reinforcement mcmber which rcinforces this jacket to thc pressure of this refrigerant in the interior of a jacket in the lincar motor which has a coil and the jackct with which this coil is covcred and a refrigcrant is supplied to a building cnvelope.
[0009] Thc stagc equipmcnt of this invention is characterizcd by having the linear motor of the above-mentioned composition as a drive, and it is characterized by for the aligner of this invention carrying a substrate with thc above-mcntioned stage equipment, and having a means to expose to this substrate. Moreover, the device manufacture method of this invention is characterized by manufacturing a device using the above-mentioned aligner.
[0010]
[Embodimcnts of the Invention]
<Examplc 1> drawing 1 is drawing showing the single phase linear motor which is 1 operation gestalt of this invention. The exploded vicw and drawing 3 drawing 2 explains a internal structure to be are the perspective diagram of a linear motor.
[0011] In drawing 1 , the coil with which thc currcnt for a drive in 1 flows, two yokes with which 2 constitutes a magnetic circuit, and 3 are permancnt magnets with which magnetic poles which are fixed to each yokc 2 and are different countcrcd mutually, and they havc been arranged. The sheet with which 4 and 4' was allottcd on both sides of the coil 1, and 5 are frames which support the sheet 4 of two sheets, and 4', and the jacket which connotes a coil 1 by this sheet 4, and 4' and a framc 5 is constituted. Junction on a sheet 4, and 4' and a frame 5 is being fixed with adhcsives, the bolt, etc. 6 is the building envelopc of this jacket and 7 is a fastener which is fixing the coil 1 to a jacket. the reinforcement whose 8 is the characteristic membcr of this operation gestalt -- it is a member and functions as a pressure-proof implemcnt which adhesion or bolt fixation is carried out at both a shcet 4 and 4', and prevents the brcadth between both rcinforcement -- the mcmber 8 is locatcd in the air core portion of the coil 1 by which the coil was carried out a shect 4, 4', a frame 5, and reinforcement -- the quality of thc material of a member 8 has non-magnetic-material material (PEEK), for example, macromolecule resin material, or a desirable ceramic material
[0012] In drawing 2 and drawing 3 , it is a stoma for 10 pulling out lead wire 10 to the lead wire (2) of a coil 1, and 11 pulling it out from the intcrior of a jacket to the exterior. Aftcr pulling out lead wire so that a refrigerant may not begin to leak from this stoma 11, the stoma is airtightly closed by the binder etc. 12 and 13 arc the supply pipes and recovcry pipes of a refrigcrant which were connected to the jacket. A refrigerant is supplicd from a supply pipe 12, flows the inside of a jacket, rcceives the generating hcat of a coil, and are discharged and collected from thc recovery pipe 13. In addition, in the coil front face, surfacc treatment is made so that the lead wire of a coil 1 itself cannot touch a direct refrigerant. A refrigcrant is a liquid or a gas and its cspecially inactive thing is desirable.
[0013] In the above-mcntioned composition, if current is passed in the coil 1 locatcd in the space between the permanent magncts 3 which have generated the fixed field system, a Lorentz force will work and a coil 1 and a permancnt magnet 3 will cxercise rclatively [direction / vertical]. For example, in the top half of this drawing, if current flows in the dirccction of this side from the back of space rightward from thc left of space, the force according to the size of currcnt will work a magnetic field to above [of space] in a coil 1, and it works downward to a permanent magnet 3, and each moves relatively. Thus, by passing predetermined current in a coil, the structure with which the yoke and the coil are being fixed, rcspectively is driven. In addition, a stator and a needle may bc reverse although the coil side servcs as a so-called MUBINGU magnet type linear motor from which thc yoke side with

which the stator and the permanent magnet were held became a needle in this example.
[0014] By supplying and pouring the refrigerant by which the temperature control was carried out to the building envelope 6 of a jacket, the heat generated when it energizes in a coil is collected, and the temperature rise of the equipment with which the temperature rise of the coil itself and the linear motor are carried, or its atmosphere is stopped. under the present circumstances, reinforcement -- since there is a member 8, it is stopping that a sheet 4 and 4' swell and deform outside by the pressure of a refrigerant
[0015] In addition, although it is fixing to a frame 5 by the fastener 7, you may make it fix a coil 1 to a sheet 4 and 4' in drawing 1 . moreover, reinforcement -- although the member 8 is not being directly fixed to a coil 1 -- reinforcement -- a coil 1 is fixed to a member 8 and you may make it omit a fastener 7 moreover, a fastener 7 and reinforcement -- you may divide and form the number of members 8 not only in one but in plurality
[0016] Since according to the above this example deformation and breakage of a jacket are suppressed even if it makes the sheet of a jacket thin, or it raises the pressure of a refrigerant, while being able to raise the flow rate of a refrigerant and being able to raise cooling efficiency, the miniaturization of a jacket can be attained, as a result the thrust of a linear motor can be raised.
[0017] <Example 2> drawing 4 is drawing showing the composition of the jacket portion of another operation gestalt of the linear motor of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 1 .
[0018] a previous example -- another -- although the frame and sheet of a member constituted the jacket -- this example -- two jacket covers 14 and 14' -- each used that with which the frame section and the sheet section were united, and has joined these jacket covers the reinforcement prepared in the air core section of a coil 1 inside the jacket -- the member 8 is fixed to a jacket cover 14 and each closing-in portion of 14' using adhesives or a bolt a coil 1 -- a fastener 7 -- minding -- reinforcement -- it is fixed to the circumference of a member 8
[0019] Since according to this composition the part mark of a jacket become fewer, and assembly becomes easy and also a joint part is only between a jacket cover 14 and 14', there is an advantage that possibility that a refrigerant will begin to leak from a bond part is small.
[0020] <Example 3> drawing 5 is drawing showing the composition of the jacket portion of another operation gestalt of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 1 .
[0021] this example -- reinforcement -- a member 8 does not penetrate the air core section of a coil 1, but it is characterized by two reinforcement members fixing between the coil side, and jacket covers 14 and the closing-in sections of 14', respectively in addition, reinforcement -- a member 8 is united with a jacket cover 14 and 14', and it is good also as the same member moreover, reinforcement -- since a coil 1, a jacket cover 14, and 14' are fixed by the member 8, a fastener 7 is also omissible
[0022] According to this composition, since a reinforcement member does not exist in the air core portion of a coil, there is an advantage that a reinforcement member can be installed, irrespective of the configuration and position of a coil.
[0023] <Example 4> drawing 6 is drawing having shown the composition of the jacket portion of another operation gestalt of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 1 .
[0024] this example is characterized by preparing a reinforcement member in the jacket cover of a jacket itself. 14 and 14' is the jacket cover which constitutes the jacket of a coil 1 and was carved in the shape of [of a coil configuration] a ring. A jacket cover 14 and 14' are mutually combined also in the air core portion of a coil 1. Combination in this air core portion is performed using adhesives or a bolt, and it is stopping that the closing-in section of a jacket cover tends to spread outside by the refrigerant pressure. That is, the jacket cover 14 and the height which 14' inside counters serve as a reinforcement member which reinforces a jacket and prevents deformation. a coil 1 -- a fastener 7 -- minding -- reinforcement -- it is fixed to the circumference of a member
[0025] According to this composition, since the part mark of a jacket become fewer further, reliability improves more. Since there is thickness for a bond part in the coil air core section especially compared

with the sheet of the closing-in section, the design of a bolting join is [that it is easy to secure the space of the bolt which joins this, and the screw section] easy.
[0026] <Example 5> drawing 7 is drawing showing the composition of the jacket portion of another operation gestalt of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 1 .
[0027] this example unites with a jacket cover 14 to the fastener 7 of the composition of previous drawing 6 , and is taken as the same member. A coil 1 is inserted in and fixed to the mold formed in the jacket cover 14, and a jacket cover 14 and 14' are combined with adhesives, a bolt, etc. Also in the air core portion of a coil 1, it is mutually combined with adhesives, a bolt, etc. and a reinforcement member is formed.
[0028] Since positioning of a coil can be performed in processing of a jacket cover while high reliability is acquired according to this composition, since part mark can be managed with the minimum, assembly is very easy.
[0029] <Example 6> drawing 8 is drawing explaining the internal structure of the jacket portion in the polyphase linear motor which is another operation gestalt of this invention.
[0030] In drawing 8 , the sheet with which coil [with which, as for 1a-1c the current for a drive flows], 4, and 4' was allotted on both sides of each coil, and 5 are frames which support the sheet 4 of two sheets, and 4', and the jacket 42 which connotes Coils 1a-1c by this sheet 4, and 4' and a frame 5 is constituted. Junction on a sheet 4, and 4' and a frame 5 is being fixed with adhesives, the bolt, etc. 7 is a fastener which is fixing coil 1 a-c. the reinforcement 8a-8c and 8a', and whose 8b' are the characteristic members of this operation gestalt -- it is a member and functions as a pressure-proof implement which adhesion or bolt fixation is carried out at both a sheet 4 and 4', and prevents the breadth between both reinforcement -- a member -- the air core portion of the coil 1 with which the coil of the 8 a-c was carried out -- reinforcement -- member 8a' and 8b' are located between the coils and coils which were arranged a sheet 4, 4', a frame 5, and reinforcement -- the quality of the material of a member 8 has non-magnetic-material material (PEEK), for example, macromolecule resin material, or a desirable ceramic material The lead wire (2 each) of coil 1 a-c pulled out in the interior shell exterior of a jacket is not illustrated. Moreover, a refrigerant is supplied from the supply pipe which is not illustrated, flows the inside of a jacket, receives the generating heat of a coil, and are discharged and collected from the recovery pipe which is not illustrated. In addition, in the coil front face, surface treatment is made so that the lead wire of a coil 1 itself cannot touch a direct refrigerant. A refrigerant is a liquid or a gas and its especially inactive thing is desirable.
[0031] Drawing 9 is a perspective diagram showing the composition of the whole polyphase linear motor. In this drawing, the yoke with which holddown-member [to which the coil train of plurality / 1 / and 42 fix a jacket to, and 43 fixes a jacket], 2, and 2' constitutes a magnetic circuit, and 3 are a yoke 2 and a permanent magnet with which magnetic poles which are fixed to 2' and are different countered mutually, and they have been arranged. 23 is a holddown member which fixes a yoke.
[0032] In the above-mentioned composition, if predetermined current is passed in the coil 1 located in the space between the permanent magnets 3 which have generated the fixed field system, a Lorentz force will work, and the jacket 42 and permanent magnet 3 containing a coil 1 exercise relatively. Moreover, since two or more coils are arranged by the driving direction, according to the coil number, the stroke of a linear motor is changeable. A stator and a needle may be reverse although the coil side serves as a so-called MUBINGU magnet type linear motor from which the yoke side with which the stator and the permanent magnet were held became a needle in this example.
[0033] By supplying and pouring the refrigerant by which the temperature control was carried out to the building envelope of a jacket, the heat generated when it energizes in a coil is collected, and the temperature rise of the equipment with which the temperature rise of the coil itself and the linear motor are carried, or its atmosphere is stopped. under the present circumstances, reinforcement -- since there are Members 8a-8c and 8a', and 8b', it is stopping that a sheet 4 and 4' swell and deform outside by the pressure of a refrigerant
[0034] in addition -- drawing 8 -- a coil 1 -- a fastener 7 -- reinforcement -- although it is fixing to

Members 8a-8c -- a sheet 4, 4', or reinforcement -- you may make it fix to member 8a' and 8b' moreover, reinforcement -- although Members 8a-8c are not being directly fixed to Coils 1a-1c -- reinforcement -- Coils 1a-1c are fixed to Members 8a-8e, and you may make it omit a fastener 7 moreover, a fastener 7 and reinforcement -- you may divide and form the number of Members 8a-8c and 8a', and 8b' not only in one but in plurality

[0035] Since according to the above this example deformation and breakage of a jacket are suppressed even if it makes the sheet of a jacket thin, or it raises the pressure of a refrigerant, while being able to raise the flow rate of a refrigerant and being able to raise cooling efficiency, the miniaturization of a jacket can be attained, as a result the thrust of a linear motor can be raised.

[0036] <Example 7> drawing 10 is drawing showing the composition of the jacket portion of another operation gestalt of the linear motor of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 9 .

[0037] a previous example -- another -- the frame which was a member, a sheet, a fastener, and reinforcement -- a part or all of a member is unified, in this example, two jacket covers 14 and 14' fixed and covered the coil, and these jacket covers are joined A jacket cover is carved by the coil configuration and Coils 1a-1c are being fixed to jacket-cover 14' in each air core section. A jacket cover 14 and 14' are mutually combined also between the air core portion of a coil 1, and coils. Combination in this air core portion and this portion between coils is performed using adhesives or a bolt, and it is stopping that the closing-in section of a jacket cover tends to spread outside by the refrigerant pressure. That is, the jacket cover 14 and the height which 14' inside counters serve as a reinforcement member which reinforces a jacket and prevents deformation.

[0038] Since according to this composition the part mark of a jacket become fewer, and assembly becomes easy and also a joint part is only between a jacket cover 14 and 14', there is an advantage that possibility that a refrigerant will begin to leak from a bond part is small. Since there is thickness for a bond part in the coil air core section especially compared with the sheet of the closing-in section, the design of a bolting join is [that it is easy to secure the space of the bolt which joins this, and the screw section] easy.

[0039] <Example 8> drawing 11 is drawing showing the composition of the jacket portion of another operation gestalt of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 9 .

[0040] the coils 1a-1c by which the sheet 4, and 4' and a frame 5 constituted the cooling jacket from this example, and the laminating was carried out -- reinforcement -- a member -- 8 a-d -- moreover, the coils 1d-1f -- reinforcement -- a member 8 -- it is characterized by therefore e-8h fixing to a sheet 4 and 4' with adhesives etc., respectively a sheet 4 and 4' -- the portion of a coil 1 -- a coil 1 and reinforcement -- since it is combined through the member 8 -- a coil 1 and reinforcement -- a member 8 functions as a pressure-proof implement in addition, a sheet 4, 4', and reinforcement -- you may unify, and it unites with a sheet 4, and 4' and a frame 5, and a member 8 is good also as the same member It is stopping that a sheet tends to spread outside by the refrigerant pressure, without preparing a reinforcement member between the air core section of a coil, or a coil.

[0041] According to this composition, since a reinforcement member does not exist in the air core portion of a coil etc., there is an advantage that a reinforcement member can be installed, irrespective of the configuration and position of a coil. It is suitable, when shifting and carrying out the laminating especially of the coil and arranging.

[0042] <Example 9> drawing 12 is drawing showing the composition of the jacket portion of another operation gestalt of the linear motor of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 9 .

[0043] in the previous example, although it was the composition that a reinforcement member did not exist in the air core portion of a coil etc., at this example, the main part of a coil is avoided in the air core section of the coil which shifted and carried out the laminating etc. -- as -- a reinforcement member -- installing -- a sheet 4 and 4' -- reinforcement -- a member -- 8 a-c couples directly The coil train is being fixed to the reinforcement member in this drawing. In addition, it unites with a sheet 4, and 4' and a

frame 5, and is good also as the same member. Moreover, in this drawing, although it adhesion or really couples directly by fabrication etc., you may combine a reinforcement member and a coil through a fastener etc. The reinforcement member is stopping that a sheet tends to spread outside by the refrigerant pressure.

[0044] Since according to the above this example deformation and breakage of a jacket are suppressed even if it makes the sheet of a jacket thin, or it raises the pressure of a refrigerant, while being able to raise the flow rate of a refrigerant and being able to raise cooling efficiency, the miniaturization of a jacket can be attained, as a result the thrust of a linear motor can be raised.

[0045] <Example 10> drawing 13 is drawing showing the composition of the jacket portion of another operation gestalt of the linear motor of this invention, and arrangement of the needle (a yoke and permanent magnet) of the outside of a jacket is the same as that of previous drawing 9 .

[0046] a previous example -- another -- the frame which was a member, a sheet, a fastener, and reinforcement -- a part or all of a member is unified, in this example, two jacket covers 14 and 14' fixed and covered the coil, and these jacket covers are joined A jacket cover is carved by the coil configuration, Coils 1a, 1d, and 1g are fixed to a jacket cover 14 in each air core section, Coils 1c and 1f are fixed to jacket-cover 14' in each air core section, and Coils 1b and 1e are being fixed to both a jacket cover 14 and 14' in each air core section. A jacket cover 14 and 14' are mutually combined through Coils 1b and 1e etc., and the closing-in section of a jacket cover is stopping that it is going to spread outside by the refrigerant pressure. That is, the height of a jacket cover 14 and 14' inside serves as a reinforcement member which reinforces a jacket and prevents deformation.

[0047] Since according to this composition the part mark of a jacket become fewer, and assembly becomes easy and also a joint part is only between a jacket cover 14 and 14', there is an advantage that possibility that a refrigerant will begin to leak from a bond part is small. Moreover, since a jacket is carved by the coil configuration, positioning of a coil is easy at the time of assembly.

[0048] <Example 11> drawing 14 shows the operation gestalt of the aligner which has a wafer stage using one which gave [above-mentioned] explanation of linear motors. In this drawing, 21 is a wafer stage which has a gate mechanism, and carries the semiconductor wafer 23 in the upper surface. The reduction projection optical system 29 which carries out reduction projection of the pattern of the illumination system 27 which has the light source and lighting optical system above the wafer stage 21, the reticle 28 equipped with the pattern which should be imprinted to a wafer, and this reticle 28 for a predetermined scale factor is formed.

[0049] The composition of a wafer stage is explained. 24 is a guide which carries out horizontal chisel regulation of the gate stage, for example, permits movement of a Z direction, the inclination direction, and a Z-axis hand of cut by using a hydrostatic bearing. 26 is the base. 25 is the linear motor equipped with the composition of one of examples which gave [above-mentioned] explanation, and can adjust the position or inclination of a Z direction which is the gravity direction of a stage 21 to the base 26 by the drive of three linear motors (the one remaining pieces are not shown). Moreover, the position and inclination of a Z direction of a stage are controllable by measuring the position and inclination of a Z direction of a stage 21.

[0050] Since the heat which the cooling efficiency of a linear motor goes up and is generated from a coil is collected according to this example, and generation of heat from a linear motor gets across to a wafer stage, and does not carry out a temperature rise or does not raise ambient temperature, the positioning accuracy of a wafer stage can be raised by leaps and bounds, as a result a highly precise exposure imprint than before is attained.

[0051] <Example 12> drawing 15 shows the production flow of the semiconductor devices (semiconductor chips, such as IC and LSI, or a liquid crystal panel, CCD, etc.) which used the above-mentioned aligner. The circuit design of a semiconductor device is performed at Step 1 (circuit design). The mask in which the designed circuit pattern was formed is manufactured at Step 2 (mask manufacture). At Step 3 (wafer manufacture), a wafer is manufactured using material, such as silicon. Step 4 (wafer process) is called last process, and forms an actual circuit on a wafer with lithography technology using the mask and wafer which carried out [above-mentioned] preparation. Step 5

(assembly) is called back process, is a process semiconductor-chip-ized using the wafer produced by Step 4, and includes processes, such as an assembly process (dicing, bonding) and a packaging process (chip enclosure). At Step 6 (inspection), the check test of the semiconductor device produced at Step 5 of operation, an endurance test, etc. are inspected. A semiconductor device is completed through such a process and this is shipped (Step 7).

[0052] Drawing 16 shows the detailed flow of the above-mentioned wafer process. The front face of a wafer is oxidized at Step 11 (oxidization). An insulator layer is formed in a wafer front face at Step 12 (CVD). At Step 13 (electrode formation), an electrode is formed in a wafer by vacuum evaporationo. Ion is driven into a wafer at Step 14 (ion implantation). A sensitization agent is applied to a wafer at Step 15 (resist processing). At Step 16 (exposure), printing exposure of the circuit pattern of a mask is carried out by exposure which gave [above-mentioned] explanation at a wafer. The exposed wafer is developed at Step 17 (development). At Step 18 (etching), portions other than the developed resist image are shaved off. The resist which etching could be managed with Step 19 (resist ablation), and became unnecessary is removed. By carrying out by repeating these steps, a circuit pattern is formed on a wafer multiplex.

[0053]

[Effect of the Invention] Since according to this invention a thin comb can also suppress deformation and breakage of a jacket for the closing-in portion of a jacket or it raises the pressure of a refrigerant, while being able to raise the flow rate of a refrigerant and being able to raise cooling efficiency, the thrust of a linear motor can be raised by the miniaturization of a jacket.

[Translation done.]